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(54) Method of making molds

(57) Molding sand (9) containing a predetermined amount of water, e.g. 2-5 weight % water, is charged into a metal mold box (2). The inner surfaces of the mold box are cooled by refrigerant, preferably prior to charging the box with the sand, to a temperature in the region of −10°C to −50°C. The sand is left in the mold box for a predetermined time period in order that the surfaces of the mold become frozen and hardened. The mold is then removed from the mold box and the entire mold is frozen and hardened by cooling with refrigerant. Alternatively, the sand may be charged into a pattern plate and molding flask assembly. Either the pattern plate only is cooled in which case the pattern plate is removed after the surface in contact with the mold has frozen and hardened and before the entire mold whilst accommodated in the molding flask is frozen and hardened by cooling, or the pattern plate and molding flask are both cooled in which case the pattern plate is removed and the mold is stripped from the molding flask before the entire mold is frozen and hardened by cooling.

FIG. 1

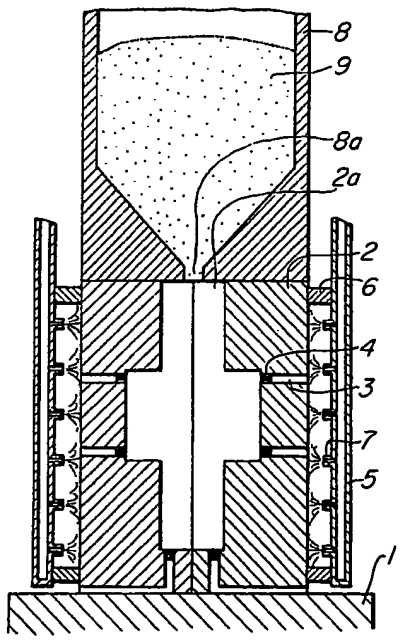

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FIG. 1

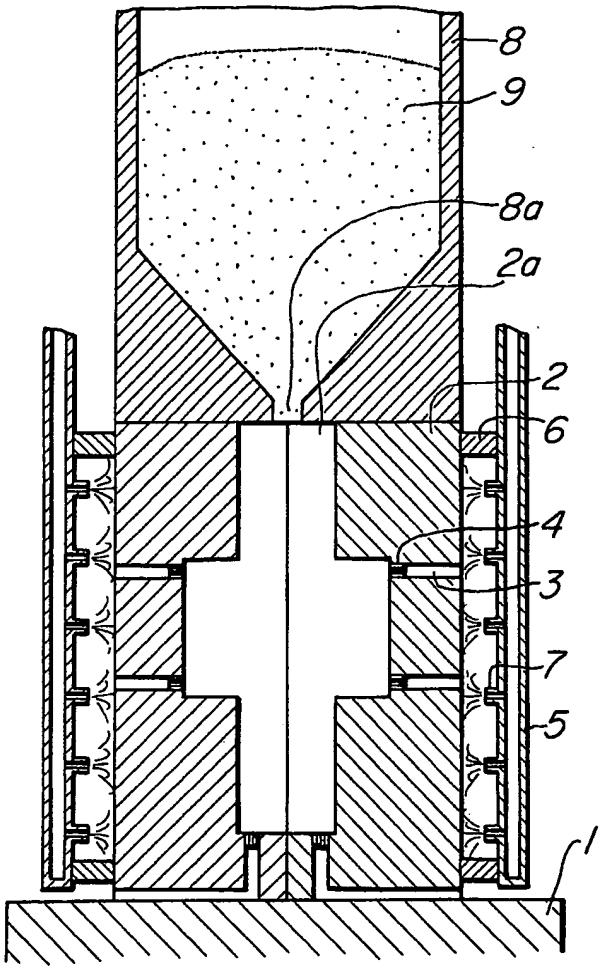

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FIG. 2

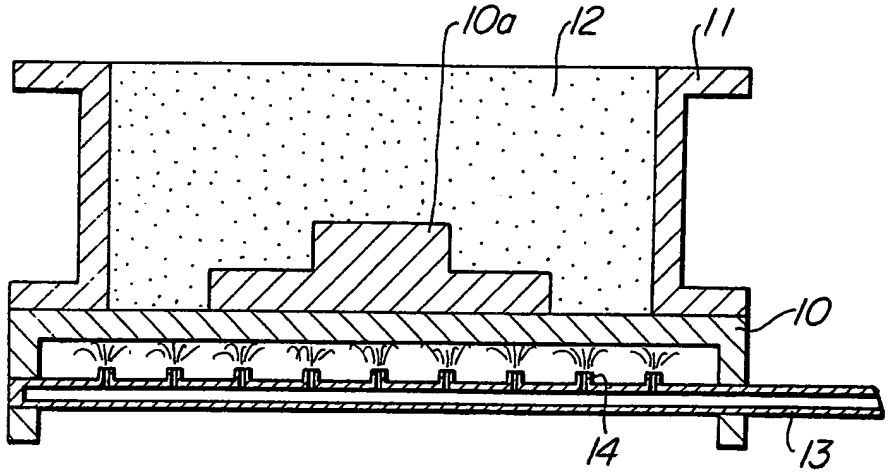
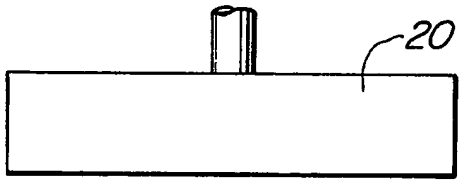


FIG. 3



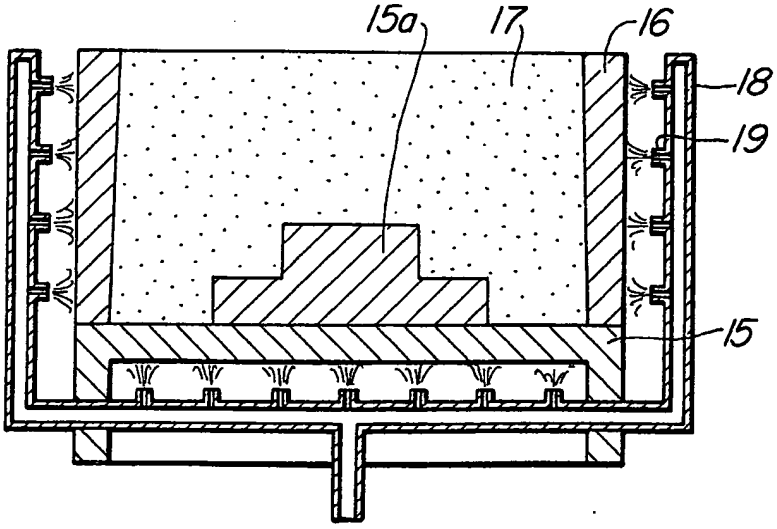


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FIG. 4

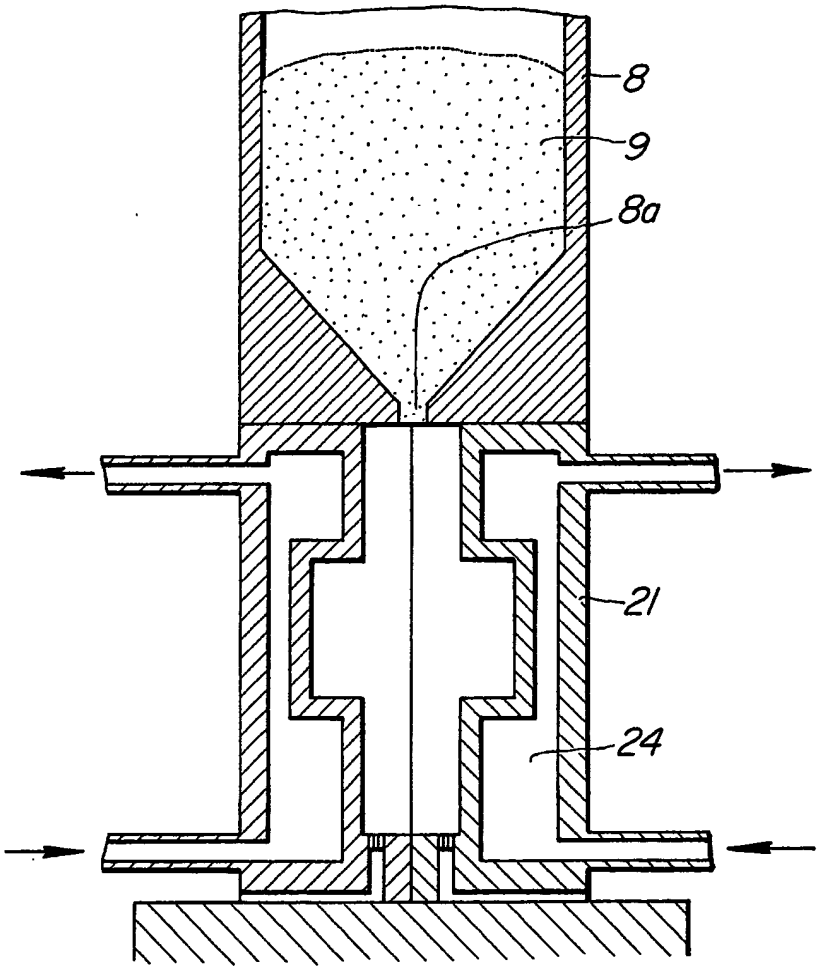

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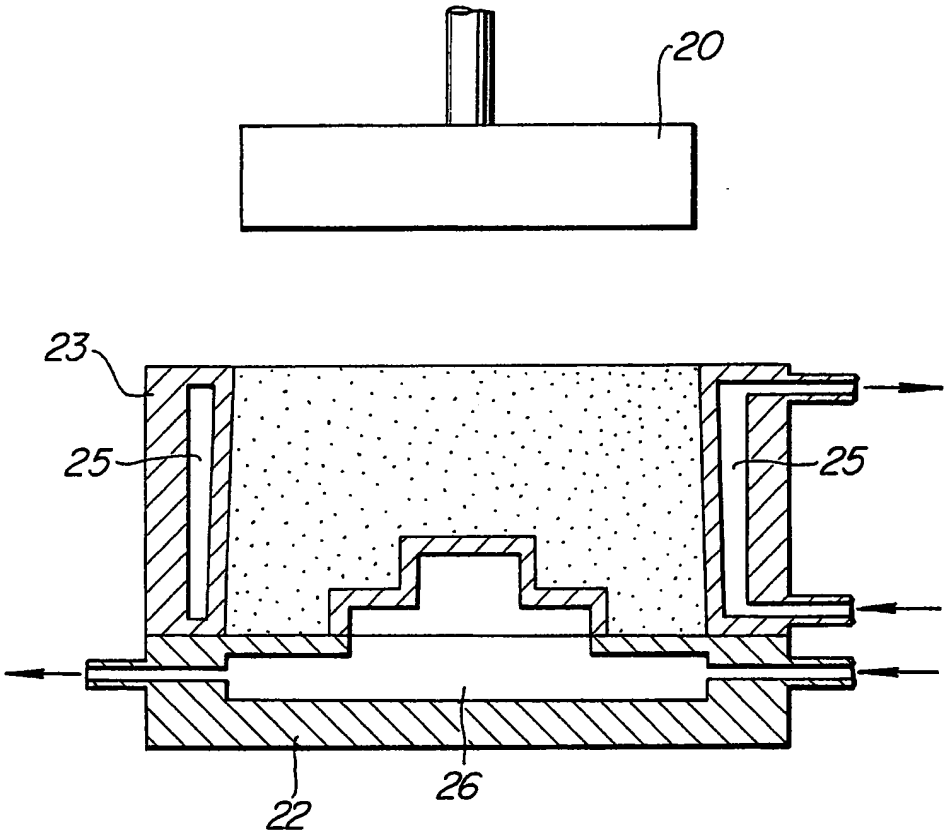
FIG. 5



SPECIFICATION

Method of making molds

This invention relates to a method of making molds, and more particularly to a method of making molds in which molding sand is frozen and hence hardened.

Recently, there has been growing tendency to make the molds by introducing molding sand containing a proper amount of water into a mold box to make an unhardened mold, then removing the unhardened mold from the mold box, and then spraying refrigerant such as liquid nitrogen onto the unhardened mold to freeze water contained in the molding sand and hence harden it. However, this method has suffered from the drawback that the unhardened mold is susceptible to damage or distortion when removed from the mold box. The refrigerant such as liquid nitrogen is sprayed onto the unhardened mold to freeze and harden the same after removing it from the mold box. It is, therefore, necessary to handle the unhardened mold very carefully, and also to use binders so as to give the mold sufficient strength to withstand the handling.

In a first aspect the invention provides a method of making a mold, comprising the steps of:-

(a) cooling by refrigerant one or more surfaces of a mold formed by charging sand containing a predetermined amount of water into a metal mold box or a molding flask and pattern plate assembly to freeze and harden said one or more surfaces,

(b) removing the mold box, pattern plate, or pattern plate and molding flask from a frozen and hardened surface or surfaces of the mold, and

(c) cooling, by refrigerant, the mold to freeze and harden the entire mold.

Preferred and/or optional features of the first aspect of the invention are set forth in claims 2-9.

Further aspects of the invention are set forth in claims 11 and 12 and preferred and/or optional features of these further aspects of the invention are set forth in claims 13-20.

The invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a sectional view showing one embodiment of the invention,

Figures 2 and *3* are sectional views showing two other embodiments of the invention, and

Figures 4 and *5* are sectional views showing another cooling means for a metal mold box, a pattern plate and a molding flask.

Referring firstly to Figure 1, the reference numeral 1 denotes a vertically movable table. A vertically split metal mold box 2 has an orifice 2*a* at the upper end thereof through which molding sand is charged into the box 2. The box 2 is placed on the surface of the table 1. Ventilating holes 3 in communication with the outside air are provided in the side walls and bottom wall of the metal mold box 2, and a vent plug 4 is fitted into each ventilating hole 3 to form a surface flush with the surface of the cavity in the mold box. The numeral 5 denotes liquid nitrogen feed pipes disposed on the outer side of the metal mold box 2. Each liquid nitrogen feed pipe 5 is supported by a supporting member 6 projecting from the outer surface of the metal mold box 2 and is provided with a plurality of nozzles 7 which are equi-distantly spaced along the side of the feed pipe facing the metal mold box 2. One end of each feed pipe 5 is communicated with a liquid nitrogen tank (not shown). The numeral 8 denotes a blowing head (or blowing machine) disposed above the metal mold box 2 and is provided with a blowing port 8*a* for molding sand at its lower end. Molding sand 9 containing a proper amount of water is stored in the blowing head 8. With the arrangement shown in Figure 1, the metal mold box 2 is held between the table 1 and the blowing head 8 and liquid nitrogen is sprayed from the nozzles 7 onto the outer surface of the metal mold box 2 so as to cool it. When the metal mold box 2 has cooled down to a predetermined temperature, compressed air is supplied to the blowing head 8 and the molding sand 9 containing a proper amount of water is blown into the cavity within the metal mold box 2 through the blowing port 8*a* and the orifice 2*a*, so that the cavity within the metal mold box 2 is filled up with the molding sand. Meanwhile, the compressed air is discharged to atmosphere through the vent plugs 4 and the ventilating holes 3. After completion of the blowing process, the table 1 is lowered to separate the metal mold box 2 from the lower surface of the blowing head 8. The moulding sand is held within the metal mold box 2 at this state for a predetermined period of time. The molding sand held within the metal box 2 is frozen and hardened at the surfaces thereof, so that a strength required to withstand subsequent handling is attained. Next, after releasing clamps (not shown) and opening the metal mold box 2, the mold is removed. Then, the mold is placed in a refrigerating chamber in order to harden the interior thereof, and thereafter is used as a frozen mold for pouring. The result of experiments utilizing such a mold will now be described.

Experiments 1 to 3 give examples in which the temperature of the metal mold box is changed.

Experiment 1

The metal mold box 2 was made to define a cavity shape of 50 mm dia. × 150 mm height. Silica sand produced in Flattery, Australia and containing 3 weight % of water added thereto was charged into the metal mold box which had been cooled down to −10°C at the surface thereof in contact with the molding sand. In this experiment, it was 60 seconds before the mold could withstand the handling for removing it from the mold box.

Experiment 2

The metal mold box was made to have a cavity shape of 50 mm dia. × 150 mm height. Silica sand produced in Flattery, Australia and containing 3 weight % of water added thereto was charged into the metal mold box which had been cooled down to −30°C at the surface thereof in contact with the molding sand. In this experiment, it was 25 seconds before the mold could withstand the handling for removing it from the mold box.

Experiment 3

The metal mold box was made to have a cavity shape of 50 mm dia. × 150 mm height. Silica sand produced in Flattery, Australia and containing 3 weight % of water added thereto was charged into the metal mold box which had been cooled down to −50°C at the surface thereof in contact with the molding sand. In this experiment, it was 10 seconds before the mold could withstand the handling for removing it from the core box.

It will be apparent from Experiments 1 to 3 that at a temperature above −10°C, the time required in order that the mold can withstand the handling will be longer and thus is unsatisfactory in practice, while at a temperature of less than −50°C, the energy loss is unacceptably high, although the time required to harden the surfaces of mold for removal of the mold becomes shorter, and thus is uneconomic in practice.

Experiments 4 to 6 give examples in which the amount of added water is changed.

Experiment 4

The metal mold box was made to have a cavity shape of 50 mm dia. × 150 mm height. Silica sand produced in Flattery, Australia and containing 2 weight % of water added thereto was charged into a metal mold box which had been cooled down to −30°C at the surface thereof in contact with the molding sand. In this experiment, it was 20 seconds before the mold could withstand the handling for removing it from the mold box.

Experiment 5

The metal mold box was made to have a cavity shape of 50 mm dia. × 150 mm height. Silica sand produced in Flattery, Australia and containing 3 weight % of water added thereto was charged into the metal mold box which had been cooled down to −30°C at the surface thereof in contact with the molding sand. In this experiment, it was 25 seconds before the mold could withstand the handling for removing it from the mold box.

Experiment 6

The metal mold box was made to have a cavity shape of 50 mm dia. × 150 mm height. Silica sand produced in Flattery, Australia and containing 5 weight % of water added thereto was charged into the metal mold box which had been cooled down to −30°C at the surface thereof in contact with the molding sand. In this experiment, it took 30 seconds before the mold could withstand the handling for removing it from the mold box.

It will be apparent from Experiments 4 to 6 that with the smaller amount of added water, the time required to harden the surfaces of the mold for removal of the mold is shorter, but the strength of the surface of the mold is less. With the larger amount of added water, the surface of the mold is of increased strength but a casting formed in this mold is subjected to defects in its appearance due to vapour from the added water and the time required to harden the surface of the mold for removal of the mold is longer.

Referring now to Figure 2, the reference numeral 10 denotes a pattern plate having a pattern 10*a* thereon. A molding flask 11 is placed on the upper surface of the pattern plate 10, and molding sand 12 containing a proper amount of water is charged into a space defined by the molding flask 11 and the pattern plate 10. The reference numeral 13 denotes a liquid nitrogen feed pipe, which is disposed under the pattern plate 10 and is provided with a plurality of nozzles 14 which are equi-distantly spaced along the side of the feed pipe facing the pattern plate 10. One end of the feed pipe is in communication with a liquid nitrogen tank (not shown).

With the arrangement shown in Figure 2, the molding sand 12 is charged into the space defined by the pattern plate 10 and the molding flask 11 and liquid nitrogen is sprayed from the nozzles 14 onto the lower surface of the pattern plate 10. As a result, the pattern plate 10 is cooled so that the molding sand 12 just above the pattern plate 10 is frozen and hardened. Then, after removing the pattern plate 10, the moulding flask 11 supporting a mold therein is placed in a refrigerating chamber so as to freeze water contained in the mold and harden the latter completely. As a result, a frozen mold is obtained which can be utilized for pouring.

Referring to Figure 3, the reference numeral 15 denotes a pattern plate having a pattern 15*a* thereon. A molding flask 16 is placed on the upper surface of the pattern plate 15, and molding sand 17 containing a proper amount of water is charged into a space defined by the molding flask 16 and the pattern plate 15. The reference numeral 18 denotes a liquid nitrogen feed pipe, which is disposed adjacent to the outer surfaces of the pattern plate 15 and the molding flask 16 assembled together. The feed pipe is provided with a plurality of nozzles 19 which are equi-distantly spaced along the sides of the feed pipe facing the pattern plate 15 and the molding flask 16 and is in communication with a liquid nitrogen tank (not shown). The reference numeral 20 denotes a plate with which the mold can be stripped from the molding flask 16.

With the arrangement shown in Figure 3, the molding sand 17 is charged into a space defined by the pattern plate 15 and the molding flask 16 and liquid nitrogen is sprayed from the nozzles 19 onto the outer surface of the pattern plate 15 and the molding flask 16. As a result, the pattern plate 15 and the molding flask 16 are cooled so that the molding sand 17 in contact with the pattern plate 15 and the molding flask 16 is hardened. Then, after removing the pattern plate 15 from the molding flask 16, the mold stripping plate 20 is entered into the molding flask 16 to strip the mold from the molding flask 16 in a downwards direction. The mold thus obtained is combined with a second mold (not shown) and placed in a refrigerating chamber as a complete mold to freeze water contained in the complete mold and harden it completely.

The embodiments shown in Figures 1 to 3 can be modified as shown in Figures 4 and 5. A hollow chamber 24, 25, 26 is formed in the walls of a metal mold box 21, a molding flask 23 and a pattern plate

22 respectively. The refrigerant is fed through the hollow chamber 24 or chambers 25, 26.

Briefly a method of making molds is provided in which molding sand containing a proper amount of water is charged into a metal mold box which has been cooled by refrigerant or into a space defined by a molding flask and a pattern plate assembly which has been cooled by refrigerant. The surface of the molding sand is frozen and hardened by leaving the mold in the box or space for a predetermined period of time. A mold is thus obtained with a hardened surface but soft interior. The mold is then removed from the metal mold box or assembly, and then cooled all over the surface by refrigerant to freeze the interior of the mold to harden the mold completely. Alternatively, molding sand containing a proper amount of water is charged into a space defined by a pattern plate which has been cooled by refrigerant and a molding flask. The molding sand in contact with the surface of the pattern plate is frozen and hardened by leaving the mold on the pattern plate for a predetermined period of time. The pattern plate is removed and then the molding sand held in the molding flask is further cooled by refrigerant, thereby to freeze and harden the molding sand within the molding flask.

A method according to the present invention has the advantage that binders do not need to be added to the mold for the purpose of handling and the mold is made with ease.

CLAIMS

1. A method of making a mold, comprising the steps of:-

(a) cooling by refrigerant one or more surfaces of a mold formed by charging sand containing a predetermined amount of water into a metal mold box or a molding flask and pattern plate assembly to freeze and harden said one or more surfaces,

(b) removing the mold box, pattern plate, or pattern plate and molding flask from a frozen and hardened surface or surfaces of the mold, and

(c) cooling, by refrigerant, the mold to freeze and harden the entire mold.

2. The method of claim 1, wherein the mold box, pattern plate, or pattern plate and molding flask assembly is/are cooled prior to charging the sand into the mold box or pattern plate and molding flask assembly.

3. The method of claim 1 or claim 2 when using a mold box, wherein the mold box is removed from the mold when the surfaces of the mold have frozen and hardened and then the entire mold is cooled.

4. The method of claim 1 or claim 2, when using a pattern plate and molding flask assembly, wherein only the pattern plate is cooled and wherein the pattern plate is removed when the surface of the mold in contact with the pattern plate frozen and then the entire mold is cooled in the molding flask.

5. The method of claim 1 or claim 2 when using a pattern plate and mold assembly, wherein the pattern plate and molding flask are cooled and wherein the pattern plate is removed and the mold stripped from the molding flask when the surfaces of the mold in contact with the pattern plate and mold have frozen and hardened and then the entire mold is cooled.

6. The method of anyone of the preceding claims, wherein the amount of water contained in the molding sand is substantially in the range 2 to 5 weight %, and the mold box, pattern plate, or pattern plate and molding flask assembly is cooled to a temperature substantially in the range −10°C to −50°C at the surface or surfaces thereof which contact the molding sand.

7. The method of anyone of the preceding claims, wherein the mold box, pattern plate, or pattern plate and molding flask assembly is cooled by passing refrigerant through a hollow chamber or chambers in the wall or walls thereof.

8. The method of anyone of claims 1-7, wherein the mold box, pattern plate, or pattern plate and molding flask assembly is cooled by directing refrigerant from nozzles at the outer wall or walls thereof.

9. The method of anyone of the preceding claims, when using a mold box, wherein the mold box is charged with sand from a blowing head under the application of compressed air and wherein air is discharged from the mold box to atmosphere *via* vent plugs and ventilating holes in the mold box.

10. A method of making molds comprising steps of previously cooling a metal mold box or an assembly composed of a molding flask and a pattern plate which define a space therein, by applying refrigerant, and filling molding sand containing a predetermined amount of water into said metal mold box or the space in said assembly to form a mold; removing said mold from said metal mold box or the space in said assembly, when the molding sand at the surface of the mold is frozen and hardened; and further cooling all over the surface of thus removed mold by applying refrigerant to freeze and harden said mold completely.

11. A method of making molds comprising steps of assemblying a molding flask and a pattern plate so as to define a space, said pattern plate being cooled by refrigerant, and filling molding sand containing a predetermined amount of water in said space to form a mold;

removing said pattern plate, when the molding sand at the surface of said mold in contact with said pattern plate is frozen and hardened; and

further cooling said mold held in said molding flask by applying a refrigerant to freeze said mold completely.

12. A method of making molds according to claim 10, wherein an amount of water contained in said molding sand is 2 ~ 5 weight %, and said metal mold box having been cooled or said assembly having been cooled has a temperature of −10°C ~ −50°C at the surface thereof in contact with the molding sand.

13. A method of making molds according to claim 11, wherein an amount of water contained in said molding sand is 2 ~ 5 weight %, and said pattern plate having been cooled has a temperature of −10 ~ −50°C at the surface thereof in contact with the molding sand.

14. A method of making molds according to claim 12, wherein the surface of said metal mold box or said assembly in contact with said molding sand is cooled by introducing and passing refrigerant through hollow chambers formed in the walls of said metal mold box or said assembly.

15. A method of making molds according to claim 11, wherein the surface of said pattern plate in contact with said molding sand is cooled by introducing and passing refrigerant through a hollow chamber in the wall of said pattern plate.

16. A method of making molds according to claim 10, wherein said molding sand containing a predetermined amount of water is filled into said metal mold box from a blowing head under the application of compressed air, the compressed air entering into said metal mold box is discharged out to the exterior through vent plugs and ventilating holes fitted or formed in said metal mold box, and said metal mold box is cooled by refrigerant.

17. A method of making molds according to claim 10, wherein said pattern plate is removed when the molding sand at the surface of said mold within the space defined by said molding flask and said pattern plate is frozen and hardened, and then said mold within said molding flask is pushed out and removed by means of a mold stripping plate.

18. A method of making molds according to claim 10, wherein said metal mold box or said assembly is cooled down to a predetermined temperature by applying refrigerant prior to the filling of said molding sand containing a predetermined amount of water in said metal mold box or the space of said assembly.

19. A method of making molds according to claim 11, wherein said pattern plate is cooled down to a predetermined temperature by refrigerant prior to the filling of said molding sand containing a predetermined amount of water in the space of said assembly.

20. A method of making a mold, substantially as hereinbefore described with reference to Figure 1, Figure 2, Figure 3, Figure 4 or Figure 5 of the accompanying drawings.

21. A mold when prepared by a method as claimed in anyone of the preceding claims.

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